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PERFORMANCE EVALUATION OF LEACHATE TREATMENT USING NATURAL ADSORBENTS

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ABSTRACT

The report deals with the evaluation of the performance of Land fill Leachate treatment using natural adsorbents. In organic and organic pollutants present in the Leachate may lead to many problems to the environment and to the nearby water bodies causing negative environmental impact. To overcome these problems, natural adsorbent materials are used. In order to find out the effective natural adsorbent for the treatment of landfill Leachate, two locally available low-cost adsorbents such as Coir Pith and Rice Husk were analyzed by using fixed bed Vertical column adsorption Studies. This study deals with the analysis of efficiency of the natural adsorbent materials over a certain period of contact time to remove the contaminants from the landfill Leachate. For this study, two vertical column reactors of same dimensions such as 10.5 cm Diameter and 1 m Length were fabricated providing the adsorbent depth of 90 cm from the bottom and the columns were packed with pre-treated neutralized Adsorbents Coir Pith and Rice Husk respectively in those columns. The semi-aerobic landfill leachate taken for this study were analyzed for its initial characteristics and noted. It was then allowed to downflow through the vertical column from the top at the flow rate of 0.5 ml/min. The treated outlet collected at the interval of 7 days from the outlet Nozzle provided at the bottom of the column and their characteristics were analyzed and compared with the initial.

KEYWORDS: Natural Adsorbents, Coir Pith, Rice Husk, Fixed Bed, Vertical Column & Leachate Treatment

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Original Article

1. INTRODUCTION

Land filling is one of the most popular and common municipal solid waste disposal techniques used in most countries around the world since it is cost-effective in practice. But it needs proper management using skilled laborers that make it difficult to execute. There are some negative effects on people as well as to the local environment especially the groundwater contamination becomes a major threat. Also, the soil becomes more polluted. When the waste started rotting or began decomposing, it will produce some harmful gases such as CO2 and Methane. On being the greenhouse gases it may contribute to global warming. The sanitary landfills have many advantages over other methods of solid waste disposal; still, their main drawback is the generation of highly toxic liquid produced as a result of the biological and physiochemical transformation progress of the waste over a period which is known as Leachate. This leachate is a kind of wastewater whose characteristics may depend on the kind of waste accumulated and it's nature and composition that may have much negative impact to the environment such as land pollution, ground water contamination, etc.

The designing of landfill must be done according to the regulation standards and operated in a proper way in order to get effective results. Initially the wastes are broken down using aerobic degradation using the oxygen molecules present in the voids in between the particles and followed by an aerobic decomposition once the available oxygen molecules gets exhausted in which the larger solid particles decompose into smaller particles and slowly begins to dissolve due to hydrolysis and changed into liquid form called leachate and produce some gases like Methane and CO2 due to the transformation and volatilization process leads to the decrease in volume of the waste while leaving the remaining particles as organic residue. It is a very long term process for the complete degradation of the wastes to achieve stability and neutralize the whole landfill environment due to the interaction and exchange of nutrients to satisfy each other's needs. Landfill liners should be provided to prevent the seepage of landfill leachate from entering the nearby water sources or the groundwater aquifers. But there is a problem of leaking through the liners may occur over its lifetime due to various reasons. Hence some efforts should be taken to collect and effectively treat the leachate. A properly engineered landfill must be provided with proper piping facilities to collect the leachate and also the landfill gases produced. Landfill gases especially Methane is flammable and have a high potential to explode under suitable conditions at certain concentrations. Hence it can be used in electricity generation by properly utilizing them. Landfill cover should be provided in order to avoid spreading of any vector-borne diseases by flies, rats, etc.

1.1 Landfill Leachate

Landfill leachate is a liquid which is dark in color similar to the sewage with a strong odor often known as a heavily polluted wastewater. It is generated from the excess water percolated through the mixture of waste materials dumped in the number of layers in the landfill. It is produced only when the sufficiently high moisture content is available as such in case of rainfall, surface runoff intrusion, snowfall, etc. in the landfill to make the liquid flow through the layers of the landfill wastes due to gravity. It helps the interaction of liquid with the wastes and helps in biochemical and hydrological reactions to takes place that makes the liquid change in its characteristics such as the increase in biological oxygen demand and also the chemical oxygen demand since it contains a high concentration of heavy metals like iron, lead, copper, zinc, manganese, ammonia nitrogen, biodegradable and non-biodegradable organic compounds and salts. The quantity of leachate produced may vary seasonally according to the amount of precipitation occurs, atmospheric moisture content, temperature, etc. The quality of leachate may be influenced by the nature and composition of the wastes and with the landfill age due to the precipitation of soluble metals and the biological breakdown of organic compounds with time, thus the concentration gets reduced. Thus, it becomes a challenge to find a treatment method appropriate to reduce the contaminants in landfill leachate.

1.2 Adsorption

Adsorption can be a potential alternative method for metal ions removal. We can use a variety of non-living natural biomass like groundnut shells, rice husk waste, potato peel waste, orange peel, crab shell, untreated coffee grounds and some living biomass like microbes, moss, yeast, fungi, algae, etc.

2. MATERIALS AND METHODS

2.1 Leachate Sampling

For this study, leachate samples were taken from the Kumbakonam Municipal dumping yard having leachate of age below 8 years were collected in 40l plastic containers. Sample analysis was then carried out in the laboratory using Standard

Waste water Analyzing Methods. All chemicals used for the analytical determinations were of Standard analytical grade. The samples of Leachate taken from the Landfill and its physical, chemical and biological characteristics were analyzed. The Solid waste disposal site situated at Karikulam near Kumbakonam in Thanjavur district as shown in figure 1. This Landfill has been used for processing the wastes generated from the Kumbakonam city and the places around.

Figure 1: Sampling Location

2.2 Fixed Bed Column

Fixed bed column adsorption studies were carried using columns of 10.5 cm diameter and 1m length as shown in figure 2. The landfill leachate is allowed to pass through the Adsorbent bed in the down flow motion at a flow rate of 0.5 ml/min. Samples were collected at one week time intervals and analyzed for pH, Chemical oxygen demand (COD), Biological oxygen demand (BOD) and Total Solids. The same must be repeated for another adsorbent material, Rice Husk and the results are then tabulated. The column was packed with adsorbent Material. The schematic representation of the column is shown in figure 3.

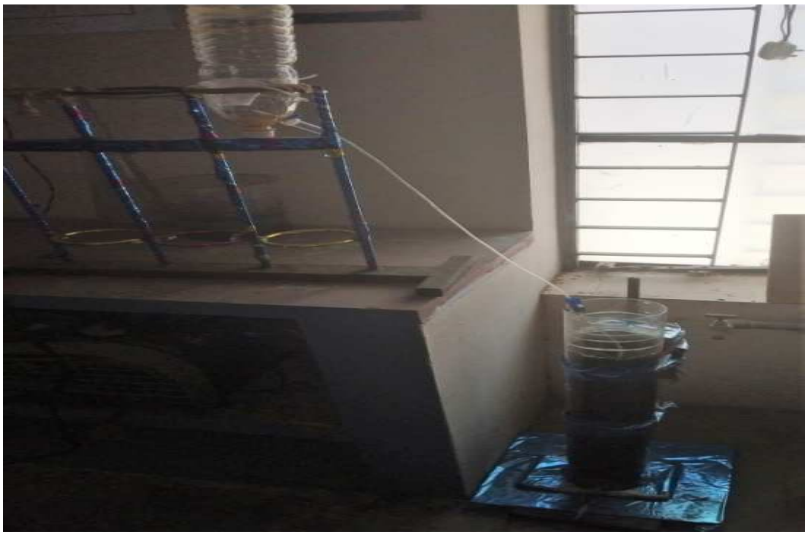

Figure 2: Fixed Bed Column Experimental Setup

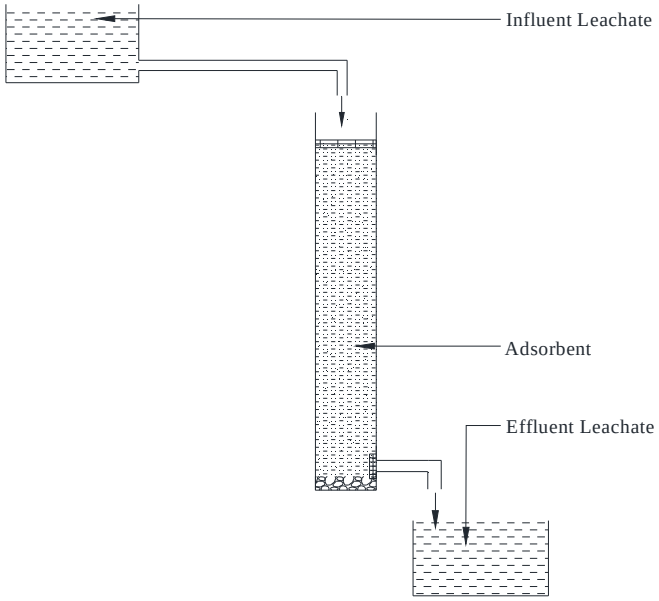

Figure 3: Fixed Bed Column-Schematic Representation

2.3 Adsorbent Materials

Table 1: Fixed Bed Column-Experimental Parameters

Parameters	Value
Column Diameter	10.5 cm
Column Height	1 m
Adsorbent Material	Rice Husk & Coir Pith
Adsorbent depth	90 cm

The Column characteristics are detailed in table 1 as shown below: In the present study, the effectiveness of coir pith over the effectiveness of rice husk as an adsorbent for leachate treatment is explored.

2.3.1 Coir Pith

Coir pith is produced as a by-product during coir production which is common in most of the villages and faces a lot of disposal problems. For this study, Raw Coir Pith was collected, cleaned, neutralized and then used for the adsorption studies.

2.3.2 Rice Husk

Rice husk is one of the low-value which have been used as an adsorbent material especially to absorb heavy metals. Rice husks are the hard protecting coverings of rice grains. Rice husk is very cost-effective agricultural by-products to obtain easily. This abundance and availability of rice husk made them a good source for natural adsorbents.

2.3.3 Adsorbent Preparation

Fresh Adsorbent Materials were collected, sun-dried, slightly crushed and sieved to remove the fibers. Wet adsorbents were washed several times with tap water, followed by distilled water wash to remove adhered as well as soluble particles and then dried in the oven at $110^{\circ C}$ for 48 hours. The citric acid solution was prepared by diluting the citric acid powder in distilled water in the ratio of 9.6 gm/l. Then the adsorbent materials are made soaked into the citric acid solution for

about 3 hours in the ratio of 7 ml solution per gram of adsorbent material, washed several times with distilled water, filtered and dried in the oven at 110$^{\circ C}$ for 48 hours. Hence, the acid wash was completed. For the Base wash to be done, Sodium Bicarbonate solution was prepared by diluting Sodium Bicarbonate powder in distilled water in the ratio of 2 gm/l. then, the adsorbent material made soaked into this solution for about 3 hours, washed with distilled water several times, filtered and dried in an oven at 110$^{\circ C}$ for 48 hours. It was then allowed to cool before proceeding to the next process under room temperature after taking from the oven for about an hour and stored. The same procedure was followed for the preparation of both Coir Pith and Rice Husk adsorbent materials.

3. RESULTS AND DISCUSSIONS

3.1 Coir Pith

The analysis of Coir Pith as adsorbent was carried out and the results are tabulated in table 2 below:

Table 2: Coir Pith as Adsorbent

S. No	Sample	pH	COD (mg/l)	BOD (mg/l)	TS (mg/l)	TDS (mg/l)
1	Initial	7.42	1572	912	17724	8842
2	Week 1	6.65	512	341	12586	6598
3	Week 2	6.34	456	304	12186	6235
4	Week 3	6.33	429	286	11384	6139
5	Week 4	6.28	384	236	9842	5046
6	Week 5	6.27	323	215	8628	5035
7	Week 6	6.25	289	193	7690	4924
8	Week 7	6.23	156	174	6052	3876
9	Week 8	6.22	118	167	5854	3743
10	Week 9	6.21	86	162	4648	2498
11	Week 10	6.20	84	152	3686	1260
12	Week 11	6.20	82	148	1249	964
13	Week 12	6.18	64	142	608	508

3.1.1 pH

The pH values are plotted in the graph shown in figure 3 below.

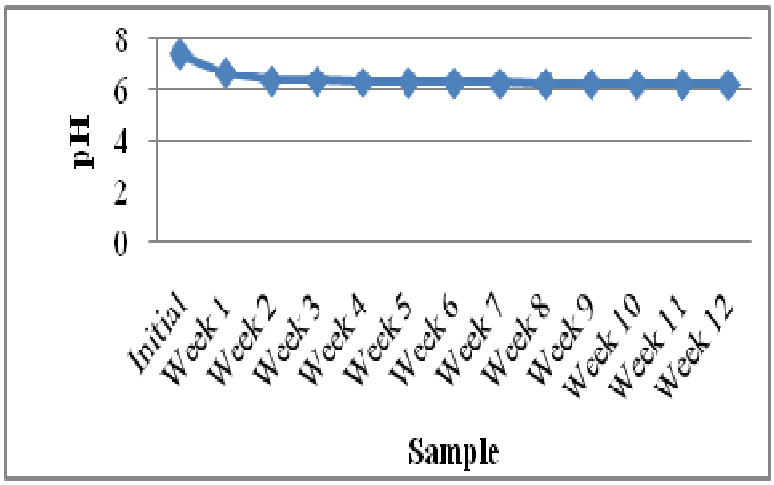

Figure 3: pH Profile for Coir Pith

3.1.2 Total Solids

The values of total solids and total dissolved solids are plotted in the graph shown in figure 4 and 5 respectively.

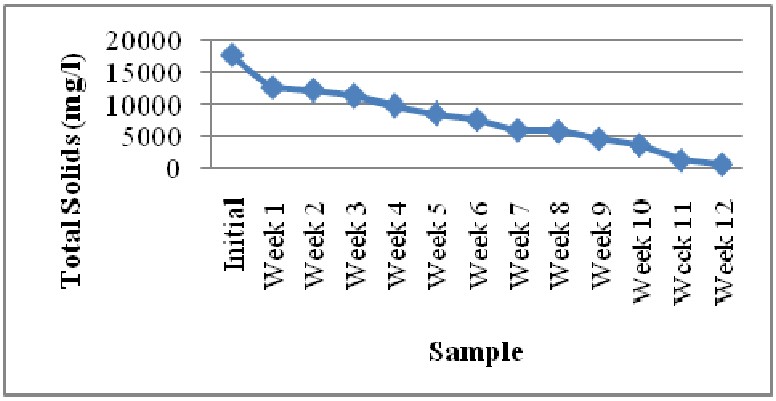

Figure 4: Total Solids Profile for Coir Pith

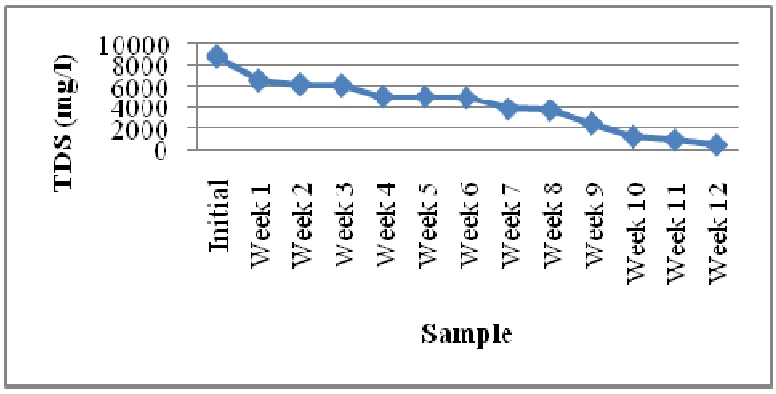

Figure 5: Total Dissolved Solids Profile for Coir Pith

3.1.3 BOD and COD

The BOD and COD values for the samples analyzed are plotted in the graph as shown in figure 6 and 7 respectively below shows that the values are decreasing from the initial value.

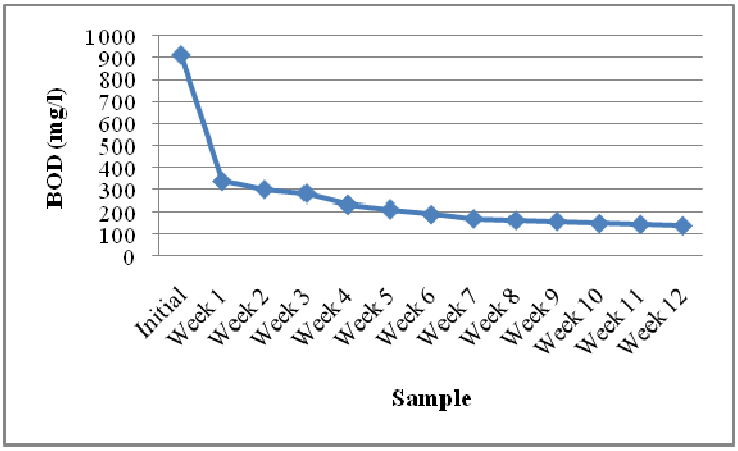

Figure 6: BOD Profile for Coir Pith

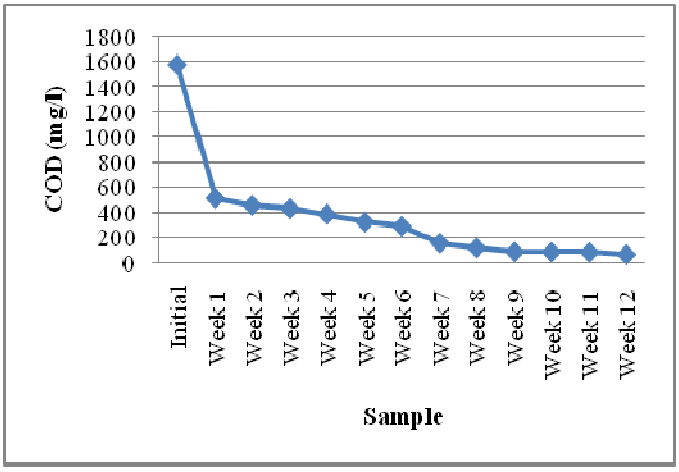

Figure 7: COD Profile for Coir Pith

3.2 Rice Husk

The analysis of Rice Husk as adsorbent was carried out according to standard methods for the samples taken and the results are tabulated in table 3 below:

Table 3: Rice Husk as Adsorbent

S. No	Sample	pH	COD (mg/l)	BOD (mg/l)	TS (mg/l)	TDS (mg/l)
1	Initial	7.42	1572	912	17724	8842
2	Week 1	6.65	512	802	12865	6582
3	Week 2	6.34	188	502	11386	6205
4	Week 3	6.26	168	402	9438	5762
5	Week 4	6.24	136	310	7432	4837
6	Week 5	6.23	65	209	6538	3286
7	Week 6	6.22	18	112	4864	2568
8	Week 7	6.24	12	105	3638	1448

3.2.1 pH

The pH profile for the Rice husk was plotted as shown in figure 8 below:

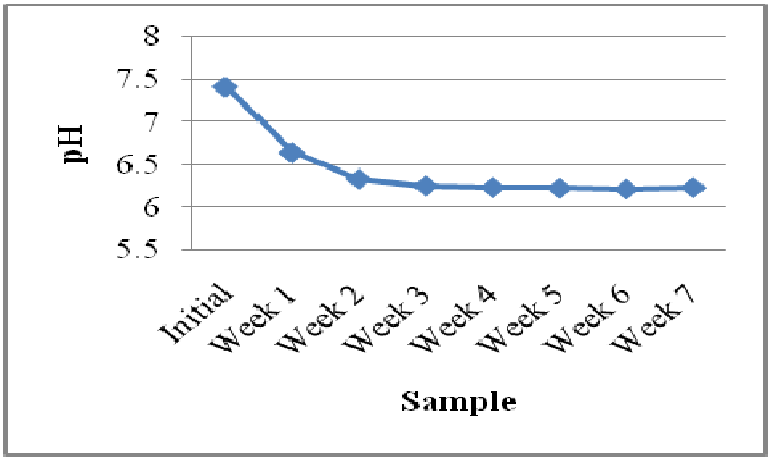

Figure 8: Ph Profile for Rice Husk

3.2.2 Total Solids

The values of total solids and total dissolved solids are plotted in the graph shown in figures 9 and 10 respectively which shows that the values are decreasing from the initial value.

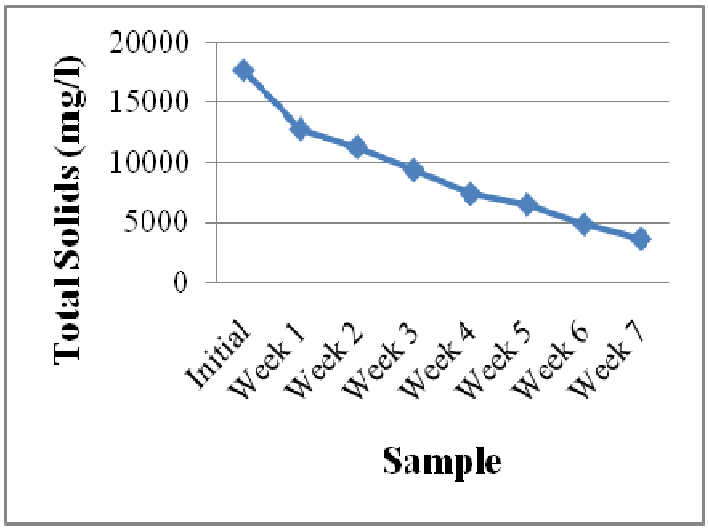

Figure 9: Total Solids Profile for Rice Husk

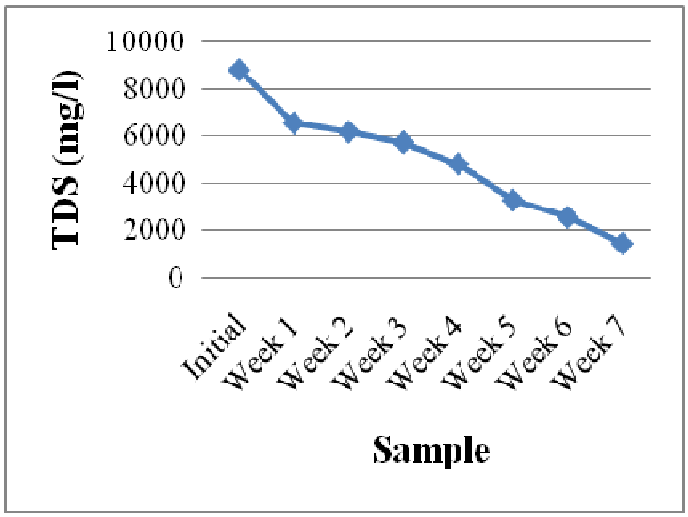

Figure 10: Total Dissolved Solids Profile for Rice Husk

3.2.3 BOD and COD

The BOD profile for the Rice husk was plotted as shown in figure 11 below:

The COD profile for the Rice husk was plotted as shown in figure 12 below shows that the values are decreasing from the initial value.

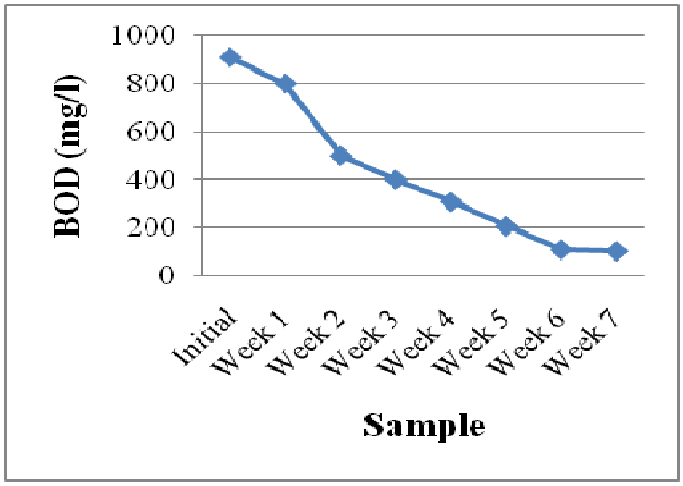

Figure 11: BOD Profile for Rice Husk

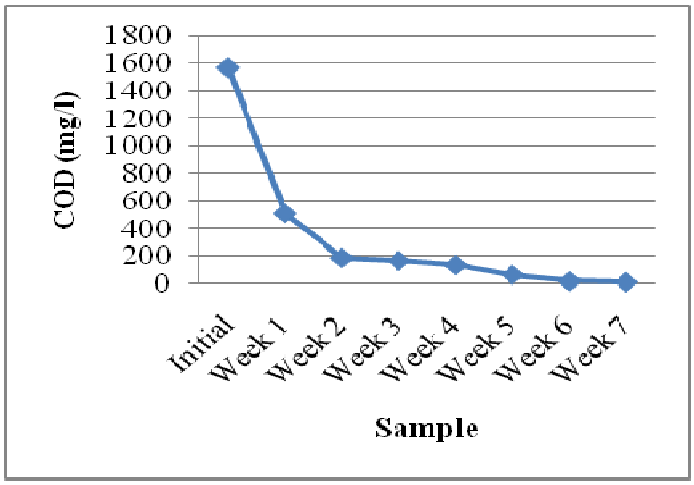

Figure 12: COD Profile for Rice Husk

4. CONCLUSIONS

- The leachate samples were collected and its characteristics were analyzed and observed such that pH as 7.42, Turbidity as 420 NTU, Chemical Oxygen Demand as 1572 mg/l, Biological Oxygen Demand as 912 mg/l, Total Solids as 17724 mg/l and Total Dissolved Solids as 8842 mg/l. Thus the evaluation of the performance of Landfill Leachate treatment using two locally available low-cost natural adsorbents such as Coir Pith and Rice Husk were analyzed by using fixed bed Vertical column adsorption Studies separately for each adsorbent.
- The leachate was allowed to flow up to down through the vertical column packed with these adsorbents at the flow rate of 0.5 ml/min. The treated outlet collected at the interval of 7 days from the outlet Nozzle provided at the bottom of the column and their characteristics were analyzed regularly.
- There is no remarkable difference in pH variation between these two adsorbents and is reduced to the value around 6.2. There is a remarkable change in Chemical Oxygen Demand and Biological Oxygen Demand at 7 weeks of time as 12 mg/l and 105 mg/l for rice husk while for coir pith, the same is observed after 12 weeks of time as 64 mg/l and 142 mg/l.

- From the results analyzed, it is observed that Rice husk as an Adsorbent is more efficient in reducing the Biological Oxygen Demand and Chemical Oxygen Demand when compared with the coir pith and showing better results in a lesser duration of treatment. Hence Rice Husk can be used more efficiently in Leachate treatment which is cost effective, easy to handle and easily available.

REFERENCES

1. *Priyabrata Banerjee, Abhijit Hazra, Pritam Ghosh, Amit Ganguly, Naresh Chandra Murmu and Pradip K. Chatterjee (2018), Solid Waste Management in India: A Brief Review, Waste Management and resource Efficiency, pp. 1027–1049.Bundhoo*
2. *Zumar M. (2018), Solid waste management in least developed countries: current status and challenges faced, Journal of Material Cycles and Waste Management, Volume 20, Issue 3, pp. 1867–1877.*
3. *Mufeed Sharholy, Kafeel Ahmad, Gauhar Mahmood and R.C. Trivedi (2008), Municipal solid waste management in Indian cities – A review, Waste Management, Volume 28, pp. 459–467.*
4. *Swati, Indu Shekhar Thakur, Virendra Kumar Vijay, and Pooja Ghosh (2018), Scenario of Landfilling in India: Problems, Challenges and Recommendations, Handbook of Environmental Materials Management, pp. 1–16.*
5. *Vrushali N. Gardare, Shivaraj Yadav (2004), Preparation of adsorbent using sugarcane bagasse by chemical treatment for the adsorption of methylene blue, Desalination and Water Treatment, 1–7.*
6. *Osnick Joseph, Maxime Rouez (2009), Adsorption of heavy metals on to sugar cane bagasse, Environmental Technology, Vol. 30, No. 13, 1371–1379.*
7. *Peng Yao, Perspectives on technology for landfill leachate treatment, American Journal of chemistry (2013).*
8. *O.I. Asubiojo and O.B. Ajelabi (2009), Removal of heavy metals from industrial wastewaters using natural Adsorbents, Toxicological & Environmental Chemistry, Vol. 91, 883–890.*
9. *S. Mohan and G. Sreelakshmi (2008), fixed bed column study for heavy metal removal using phosphate treated rice husk, Journal of Hazardous Materials 153, 75–82.*
10. *Poh-Eng Lim, Suat-Ping Lim, Chye-Eng Seng and Ahmad Md Noor (2010), Treatment of landfill leachate in sequencing batch reactor supplemented with activated rice husk as adsorbent, Chemical Engineering Journal 159, 123–128.*
11. *Paul, H., & Sarkar, P. (2013). A study and comparison of OLSR, AODV and ZRP routing protocols in ad hoc networks. International Journal of Research in Engineering and Technology, 2(8), 370–374.*
12. *Pablo D. Rocha, Adriana S. Franca, and Leandro S. Oliveira (2015), Batch and Column Studies of Phenol Adsorption by an Activated Carbon Based on Acid Treatment of Corn Cobs, International Journal of Engineering and Technology, Vol. 7, No.6.*
13. *Azhar Abdul Halim, Hamidi Abdul Aziz, Megat Azmi Megat Johari, Kamar Shah Ariffin, and Mohammed J.K. Bashir (2012), Semi-Aerobic Landfill Leachate Treatment Using Carbon–Minerals Composite Adsorbent, environmental engineering science, Vol. 29, No.5.*

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